HE
18.5
.A37
no.
DOT-
TSC-
UMTA-
84-13

UMTA-MA-06-0153-84-1
DOT-TSC-UMTA-84-13

U.S. Department of Transportation
Urban Mass Transportation Administration

Transit Reliability Information Program Final Technical Report

DEPARTMENT OF TRANSPORTATION
OCT 10 1984
LIBRARY

A. S. Millen
D. R. Cohen

Dynamics Research Corporation
Systems Division
60 Concord St.
Wilmington MA 01887

May 1984
Final Report

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

UMTA Technical Assistance Program

THIS DOCUMENT IS DISSEMINATED UNDER THE SPONSORSHIP OF THE DEPARTMENT OF TRANSPORTATION IN THE INTEREST OF INFORMATION EXCHANGE. THE UNITED STATES GOVERNMENT ASSUMES NO LIABILITY FOR THE CONTENTS OR USE THEREOF.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTA-MA-06-0153-84-1	PB84-231117	

4. Title and Subtitle

Transit Reliability Information Program, (TRIP) Final Technical Report.

5. Report Date: May 1984

6. Performing Organization Code: DTS-66

7. Author(s): A. S. Millen and D. R. Cohen

8. Performing Organization Report No.: DOT-TSC-UMTA-84-13

9. Performing Organization Name and Address
Dynamics Research Corporation*
Systems Division
60 Concord Street
Wilmington, Massachusetts 01887

10. Work Unit No. (TRAIS): MA-06-0153(UM476/R4632)

11. Contract or Grant No.: DTRS-57-81-C-00084

DEPARTMENT OF TRANSPORTATION
OCT 10 1984
LIBRARY

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Urban Mass Transportation Administration
400 Seventh Street, S.W.
Washington, D. C. 20590

13. Type of Report and Period Covered: Final Technical Report Sept.78 - Feb.84

14. Sponsoring Agency Code: URT-11

15. Supplementary Notes
*Under contract to: U.S. Department of Transportation
Research and Special Programs Administration
Transportation Systems Center
Cambridge, Massachusetts 02142

16. Abstract

The Transit Reliability Information Program (TRIP) is a government-initiated program to assist the transit industry in satisfying its need for rail transit car subsystem reliability information. TRIP provided this assistance through the operation of a National Data Bank. This Data Bank collected, stored and analyzed data which was generated by transit operators during the course of revenue service operation and equipment maintenance. The results of the periodic analyses of the stored data were distributed to TRIP participants and users. This report contains a summary of the development, operation, expansion activities, results achieved and conclusions during the initial phase of TRIP from its commencement in September 1978 through its completion in February 1984. TRIP was designed as a three-phased program. Phase I consists of defining the functional and operational requirements of the TRIP Data Bank, which includes designing, implementing and operating an Experimental Data Bank for the purpose of evaluating design concepts of the full scale Data Bank prototype. Phase II consists of expanding the scope of the Data Bank to include all aspects of vehicles involved. Phase III consists of the expansion of the TRIP Data Bank to include other classes of equipment. Phases II and III have not been implemented.

The report concludes that the TRIP concept of a National Rapid Transit Vehicle Reliability Data Bank, which collects, sorts and processes data generated by operating transit authorities in the course of revenue service operation and equipment maintenance, thereby assisting the transit industry in satisfying its need for transit reliability information, has been proven. With the concept having been proven, the authors recommend that TRIP should be utilized for continuing reliability information analysis and dissemination. Alternatives to the continuation of present operations include: 1) no further data entry - perform analyses using existing data; and 2) use of TRIP in developing, refining or optimizing maintenance programs through the identification of system, subsystem, assembly, etc., and failure rates.

17. Key Words	18. Distribution Statement
Data Bank; Generic Mapping; Transit Car Subsystem Reliability; Transit Reliability Information Program; TRIP	Available to the Public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		A04

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

PREFACE

The Transit Reliability Information Program (TRIP) is a government-initiated program to assist the transit industry in satisfying its needs for transit reliability information. TRIP provides this assistance through the operation of a national reliability Data Bank. This Data Bank collects, stores, and analyzes data which is being generated by transit operators in the course of revenue service operation and equipment maintenance. The results of periodic analyses of the stored data are distributed to TRIP participants and users.

TRIP was designed as a three-phased program. Phase I consists of defining the functional and operational requirements of the TRIP Data Bank, and designing, implementing, and operating an Experimental Data Bank for the purpose of evaluating the design concepts of the (full-scale) Data Bank on a prototype scale. Phase II consists of expanding the scope of the data bank to include all aspects of vehicles involved. Phase III consists of the expansion of the TRIP Data Bank to include other classes of equipment. Phases II and III have not been implemented.

This report contains a summary of the results achieved and conclusions reached during initial phase of the Transit Reliability Information Program. This Final Technical Report has been prepared by the Dynamics Research Corporation (DRC), Wilmington, Massachusetts, under Contract Number DTRS-57-81-C-00084, issued by the U.S. Department of Transportation (DOT), Transportation Systems Center (TSC), on behalf of the Office of Systems Engineering of the Urban Mass Transportation Administration (UMTA), Office of Technical Assistance, U.S. DOT.

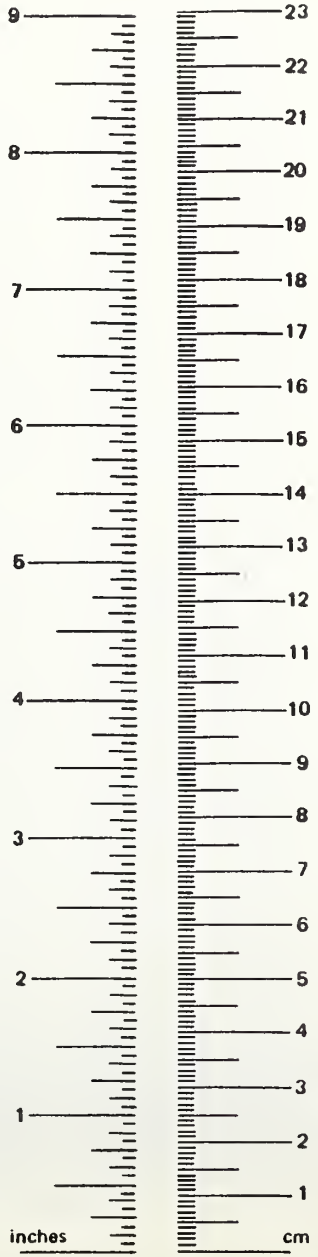
The author wishes to thank all those individuals from the transit authorities, the suppliers, the American Public Transit Association, and the U.S. Department of Transportation who provided data and assistance during this effort.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in^2	squere inches	6.5	squere centimeters	cm^2
ft^2	squere feet	0.09	squere meters	m^2
yd^2	squere yards	0.8	squere meters	m^2
mi^2	squere miles	2.6	squere kilometers	km^2
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grems	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teespoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	querts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
TEMPERATURE (exact)				
°F	Fehrenheit temperature	5/9 (after subtrecting 32)	Celsius tempereture	°C

*1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS Misc. Publ. 286. Units of Weight end Measures. Price $2.25 SD Catalog No. C13 10 286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yerds	yd
km	kilometers	0.6	miles	mi
AREA				
cm^2	squere centimeters	0.16	square inches	in^2
m^2	squere meters	1.2	square yards	yd^2
km^2	squere kilometers	0.4	square miles	mi^2
ha	hecteres (10,000 m^2)	2.5	acres	
MASS (weight)				
g	grems	0.035	ounces	oz
kg	kilogrems	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	querts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	36	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
TEMPERATURE (exact)				
°C	Celsius tempereture	9/5 (then add 32)	Fahrenheit tempereture	°F

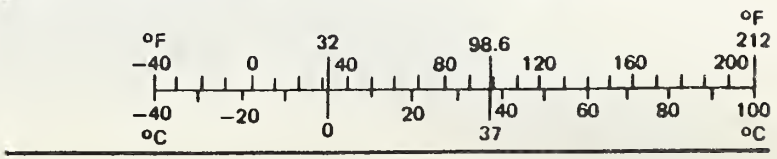


TABLE OF CONTENTS

Page

1. INTRODUCTION....1

2. PHASE I REPORT SUMMARY....6

2.1 CONTRACT TASK SUMMARY....6
2.2 CRITICAL DESIGN REVIEW I....12

3. FINAL TECHNICAL REPORT FOR CONTRACT DOT-TSC-1559 SUMMARY..14

3.1 CONTRACT EXTENSION....14
3.2 CRITICAL DESIGN REVIEW II....15
3.3 LIAISON BOARD MEETING NO. 11....17
3.4 CONTRACT COMPLETION....17
3.5 SPECIAL REPORT NUMBER 6....18

4. ACTION AREA I REPORT SUMMARY....20

4.1 CONTRACT SCOPE....20
4.2 ACTION AREA I TASK SUMMARY....21

4.2.1 TASK A SUMMARY....22

4.2.1.1 DATA BASE OPERATION....22
4.2.1.2 SPECIAL REPORT NUMBER 7....24
4.2.1.3 LIAISON ACTIVITIES....24

4.2.2 TASK B SUMMARY....25

4.2.2.1 INPUT/UPDATE SOFTWARE MODIFICATIONS..25
4.2.2.2 OUTPUT SOFTWARE MODIFICATIONS....27
4.2.2.3 SOFTWARE MODIFICATIONS FOR DATA BASE EXPANSION....28

4.2.3 TASK C SUMMARY....28

5. ACTION AREA II REPORT SUMMARY....30

5.1 TASK A SUMMARY....30
5.2 TASK B SUMMARY....31
5.3 TASK C SUMMARY....31

TABLE OF CONTENTS CONT'D

Page

6. TRIP ACTIVITIES SINCE PUBLICATION OF THE ACTION I AND II REPORTS.....32

6.1 ACTION AREA I ACTIVITIES.....32

6.1.1 TASK A ACTIVITIES.....32
6.1.2 TASK B ACTIVITIES.....36
6.1.3 TASK C ACTIVITIES.....36

6.2 ACTION AREA II ACTIVITIES.....36
(Special Report Number 8)

6.3 ACTION AREA III ACTIVITY.....37

7. SUMMARY AND CONCLUSIONS.....38

7.1 RESULTS UNDER CONTRACT NUMBER DTRS-57-81-C-00084....38

7.2 CONCLUSIONS AND RECOMMENDATIONS.....40

APPENDIX

REPORT OF THE QUANTIFICATION OF TRIP BENEFITS

LIST OF FIGURES

Page

2-1 TRIP CONTRACT APPROACH.....8

LIST OF TABLES

Page

7-1 MAJOR CONTRACT EVENTS.....41

7-2 TECHNICAL REPORTS.....45

7-3 NATIONAL TECHNICAL INFORMATION SERVICE (NTIS) REPORTS.....47

SECTION 1 - INTRODUCTION

The purpose of this document is to provide a summary of the development, operation and expansion activities of the Transit Reliability Information Program (TRIP) from the initial Contract (DOT-TSC-1559) commencement in September, 1978, through the second, and final Contract (DTRS-57-81-C-00084) termination in December, 1983. The approach taken to accomplish this is to provide a summary of the reports and activities under these two contracts.

First Contract:

- Phase I Report (DRC Report No. R-341U; April 1981)
- Final Technical Report for Contract DOT-TSC-1559 (DRC Report No. R-377U; September 1981)

Second Contract:

- Action Area I Report for Contract DTRS-57-81-C-00084 (DRC Report No. R-403U; December 3, 1982)
- Action Area II Report (DRC Report No. R-412U; February 4, 1983)
- Activities since the Action Area I and II Reports
- Critical Design Reviews I, II and III

TRIP is a government-initiated program to assist the transit industry in satisfying its need for transit reliability information. TRIP provides this assistance through the operation of a national reliability Data Bank. This Data Bank collects, stores, and analyzes rail transit system maintenance data which was generated by transit operators in the course of revenue service operation and equipment maintenance. The results of periodic analyses of the stored data were distributed to TRIP participants and users. The original goals of TRIP were to:

- Amalgamate current reliability efforts within the transit industry, and provide a focal point for a consolidated reliability effort
- Promote uniform reliability-related definitions for the transit industry
- Provide a central repository for voluntary submittal of transit industry field failure data
- Provide uniform processing and analysis of reliability data
- Provide means for periodic distribution of reliability data to potential users
- Provide data for factual comparison of reliability between related equipments
- Provide substantive data for specifying new equipment procurements and justifying product

improvement projects and supporting system analysis programs.

These goals were revised at the APTA TRIP Liaison Board (ATLB) Meeting No. 15, held at APTA Headquarters in Washington DC on November 16, 17, 1982. The Revised TRIP Goals/Objectives, based on the continuance of the existing Data Bank, as agreed to by UMTA, TSC and the ATLB at this meeting were:

- Optimize Transit Equipment Reliability
- Optimize Transit Equipment Maintenance
- Maximize Cost-Effectiveness of Reliability and Maintenance efforts.

The Means, developed at this meeting, to be used in achieving the Revised TRIP Goals/Objectives were:

- Coordinate and continue to amalgamate current reliability and maintainability efforts within the transit industry
- Maintain a central repository for voluntary submittal of transit equipment failure data
- Provide means for periodic distribution of maintenance action data to users

- Provide data for comparison or analysis of equipment reliability

- Provide data for specifying new equipment, justifying product improvement projects and supporting systems analysis programs.

TRIP was designed as a three-phased program. Phase I consists of:

- Definition and scoping of the functional and operational requirements of the TRIP Data Bank

- Design, implementation, operation, and enhancement of a Rail Rapid Vehicle (RRV) Experimental Data Bank (EDB) for the purpose of evaluating the design concepts of the (full-scale) TRIP Data Bank (DB) on a prototype scale

- Design, implementation, operation, and enhancement of an EDB for buses.

Phase II was planned to consist of merging the two EDBs into a single data bank and expanding the scope of the data bank to include all aspects of the vehicles involved. Phase III was planned as the expansion of the TRIP Data Bank to include other classes of equipment, e.g., fare collection, track and structures, wayside, eletrification etc.

TRIP is currently in Phase I. An EDB for buses was never made operational and therefore there has been no

merging of the two EDBs into a single Data Bank (non-experimental). The BUS TRIP effort was redirected by UMTA toward improving the reliability of specific equipment. The term "experimental" was eliminated in January 1983 from the Rail TRIP DB and the Data Bank was considered completely operational after January, 1983. This is the result of achieving the goal and objectives of Action Area I (AAI) of the TRIP Continuation Contract (Contract Number DTRS-57-81-C-00084).

SECTION 2 - PHASE I REPORT SUMMARY

This section summarizes the Phase I Final Report of April 1981 (DRC Report No. R-341U) which contains the results achieved and conclusions reached during the initial phase of TRIP as directed by the Transportation Systems Center (TSC), on behalf of the U.S. Department of Transportation's Urban Mass Transportation Administration (UMTA), Office of Technology, Development and Deployment.

2.1 CONTRACT TASK SUMMARY

On September 18, 1978, Dynamics Research Corporation (DRC) began work to define, develop, and establish the Transit Reliability Information Program (TRIP). The objective of this effort was to develop a comprehensive coordinated approach to transit vehicle reliability assessment by satisfying the following program requirements:

- Consolidated data system to provide a central source of reliability information for all transit vehicles which would collect, screen, and store the necessary data

- Reliability data analysis including determination of the type and quantity of data to be collected, methods for analyzing and summarizing input data, and analytical approaches for detailed reliability investigations

- Reliability assessment support to assist participants and other groups in reliability research and analysis by providing prompt, timely outputs and reports, and by providing the capability for special data searches and analyses.

The individual tasks which were contained in the contract include:

Task 1	Evaluate/Assess Data Banks/Pools
Task 2	Define/Scope TRIP Data Bank
Task 3	Establish/Prioritize Rapid Rail Equipment Lists
Task 4	Define/Recommend/Prepare Trip Guidelines
Task 5	Prepare/Conduct Regional Meeting Presentations
Task 6	Produce a Railcar Standardization Reliability Plan
Tasks 7&11	TRIP EDB Data Preparation Assistance
Tasks 8&12	Establish/Operate Experimental Data Bank
Task 9	Modify/Improve Trip Operating Procedures
Task 10	Critical Design Review Presentation

These tasks are summarized in Figure 2-1 which depicts the TRIP contract approach.

The major activities in the technical approach proposed by DRC for TRIP were to:

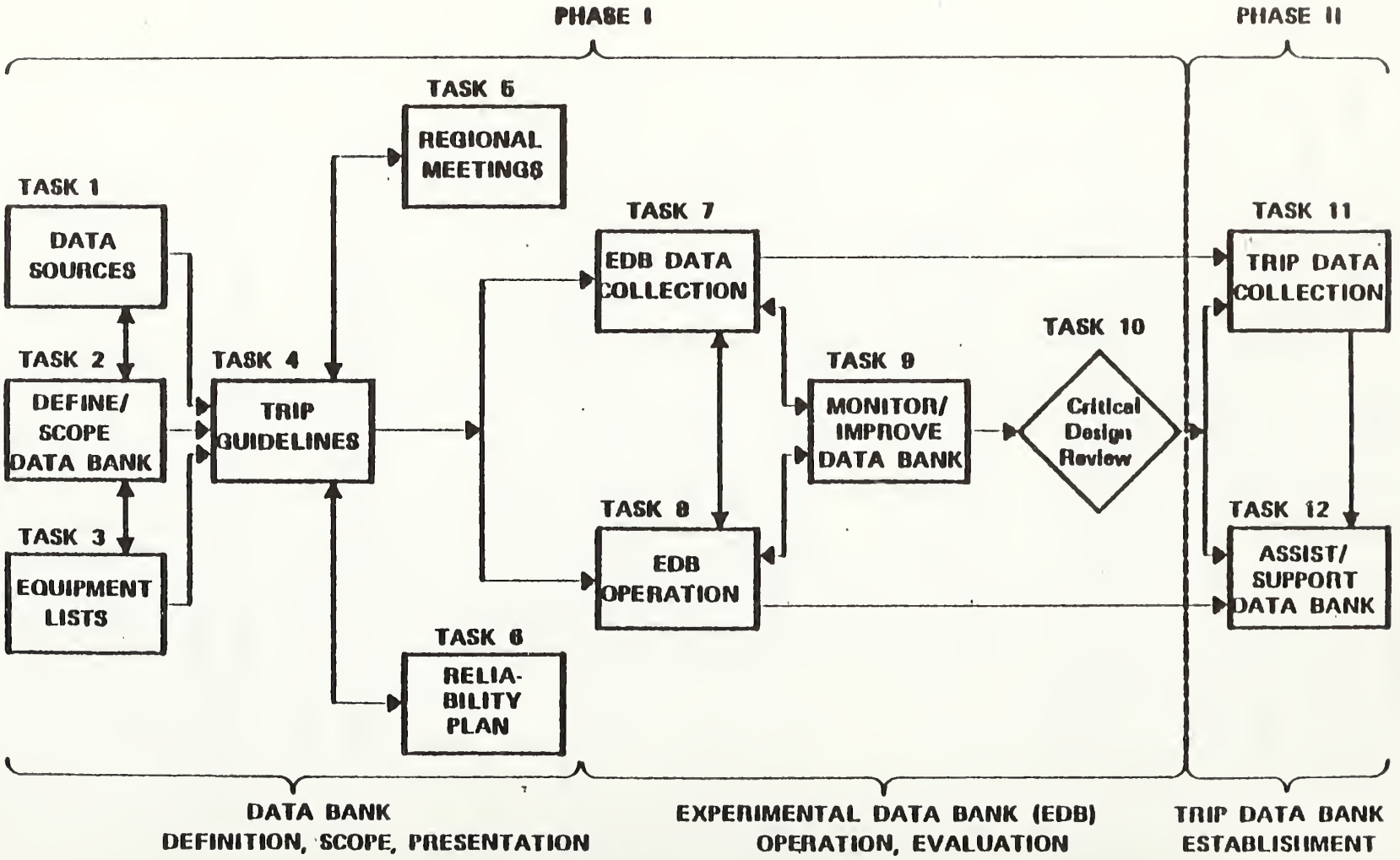


FIGURE 2--1. TRIP CONTRACT APPROACH

- Define and document TRIP functional and operational requirements necessary to satisfy the aforementioned program requirements

- Develop, establish, and operate an Experimental Data Bank (EDB) as a prototype of the full-scale TRIP Data Bank for the purpose of evaluating the proposed methodology

- Establish the (full-scale) TRIP Data Bank.

The first two activities which include tasks 1-10 comprise Phase I of the contract effort and cover the planning, designing, and testing of a small scale (experimental) data bank. The purpose of the Experimental Data Bank (EDB) was to provide a working "model" which could be used to evaluate the concepts of the full-scale TRIP Data Bank developed during the first major activity above, and to refine procedures for data acquisition, storage, retrieval, and applications for output reports. The results of this evaluation were used in activity three to formulate recommendations for continuing the operation of the Data Bank and expansion into a full scale system.

The American Public Transit Association (APTA), under separate contract to TSC, established the TRIP Liaison Board consisting of representatives from U.S. rail transit authorities and transit equipment manufactures. The Liaison Board has provided continuous guidance for the development of TRIP and the EDB through a series of periodic meetings. At the contract "kick-off" Liaison Board meeting six transit authorities volunteered to participate in the development of

TRIP by supplying data to the EDB. The six authorities were:

BART	- Bay Area Rapid Transit District
CTA	- Chicago Transit Authority
GCRTA	- Greater Cleveland Regional Transit Authority (Later replaced by MARTA)
NYCTA	- New York City Transit Authority
PATCO	- Port Authority Transit Corporation
WMATA	- Washington Metropolitan Area Transit Authority

The development of the TRIP Data Bank began with an investigation of existing reliability data banks and an analysis of the data collection and reporting approaches being used in the transit industry. The results of these investigations were used to formulate a functional definition of the TRIP Data Bank. Each of the required TRIP Data Bank functions was further defined into modular "elements" which were then translated into preliminary design requirements and specifications.

A vital part of the TRIP Data Bank design was the development of a uniform system of transit vehicle component identification, the TRIP "Generic Part Number" (GPN). The GPN is a code by which equipment of a similar function is classified and grouped according to that function. The purpose of the GPN is to provide a common numbering system to which the individual part numbering systems used at the various transit authorities can be cross-referenced. The GPN is the major "key" by which component data is sorted in the TRIP Data Bank and, because of its orientation toward

equipment function, provides a means for efficient data retrieval in support of analytical comparison of functionally similar equipment.

The TRIP Liaison Board recommended three rail vehicle subsystems (doors and door controls, propulsion, and friction brakes) for use as "pilot equipment" in the EDB. Procedures were subsequently developed for preparing the "Generic Parts List" (GPL), the cross-reference table of transit authority part numbers versus Generic Part Numbers.

Following the successful completion of the Software Acceptance Test, the TRIP Experimental Data Bank began operation on August 6, 1979, with the input of July data from BART and WMATA. EDB refinement and expansion has characterized TRIP activities since the initiation of operation. Expansion of the "input side" of the EDB continued with the inclusion of CTA and PATCO in November, 1979, and NYCTA in February, 1980. MARTA was brought on-line in April 1982.

The first EDB Output Report was published in September 1979, and contained the July data for BART and WMATA. The TRIP Liaison Board reviewed the report and recommended several modifications to format and content. EDB Output Reports were subsequently published in November, 1979 (August and September data), March, 1980 (November 1979 data), and July, 1980 (March data).

It is on the "output side" of the EDB where emphasis on the word "experimental" occurred. Each of these EDB Output Reports was a major revision of the previous report in terms of both format and content. Methods of presenting the data, level of detail, accuracy and validity, statistical significance, etc.; all of these, and more were of concern to the Liaison Board members, and their concern has been reflected in the high level of interest expressed in the presentation of information from the EDB.

2.2 CRITICAL DESIGN REVIEW I

The first Critical Design Review (CDR) of TRIP was established and held at APTA Headquarters on March 31, 1980. The purpose of the Critical Design Review (CDR) was to review Phase I activities and accomplishments, and to assess whether or not the time was appropriate to commence with Phase II of the TRIP Implementation Plan. The CDR Committee, consisting of the TRIP Liaison Board representatives from the six authorities participating in the EDB operation and representatives from APTA, UMTA, TSC, and DRC reviewed the preceeding 24 months of TRIP activity. The general consensus of the EDB authority representatives was that TRIP is a worthwhile program and should be continued. It was further concluded that TRIP could not be properly evaluated without 12 to 18 months of additional EDB experience. The net effect of the first CDR was to extend the duration of Phase I of the Implementation Plan postponing the commencement of Phase II by 15-21 months.

The conclusion of Phase I, based upon the comments of the First Critical Design Review (CDR-I) Committee expressed during the first CDR of TRIP, was that the full benefit of TRIP had yet to be realized i.e., the major benefits will be derived from long-term operation of the Data Bank.

This conclusion formed the basis of recommendations for the implementation, expansion, and operation of the full-scale Data Bank. Generally, recommendations were made in the areas of alternative approaches to TRIP operation, maintenance, and expansion (O, M&E), of the Data Bank from its experimental to full-scale configuration, and long-term operation of the Data Bank. Specifically, these recommendations are summarized as follows:

- Dynamics Research Corporation (DRC) should continue to operate the TRIP Experimental Data Bank for an additional year in order to allow more time to:

  - explore the full potential of the system
  - develop output reports
  - refine system operation
  - develop more confidence in the system.

- A second CDR should take place one year hence to again consider the timing of EDB expansion into a full-scale system.

SECTION 3 - FINAL TECHNICAL REPORT FOR CONTRACT DOT-TSC-1559 SUMMARY

This section summarizes the activities which occurred in the TRIP program covered in the Final Technical Report for the initial Contract DOT-TSC-1559 (DRC Report No. R-377U).

3.1 CONTRACT EXTENSION

An Engineering Change Order (ECO) was issued by the Transportation Systems Center (TSC) to continue operation of the TRIP Experimental Data Bank (EDB) for a contiguous period until 12 consecutive monthly output reports had been published. This ECO thus extended the period of performance of Contract Number DOT-TSC-1559 from April 18 to July 31, 1981.

Twelve monthly reporting periods were specified so that the output records of the RRV EDB would span a full year and thus provide information on seasonal trends in equipment replacement rates. Production of monthly output reports began with publication of "TRIP EDB Output Report for the Month of June 1980". The final monthly report published under Contract Number DOT-TSC-1559 was, therefore, "TRIP EDB Output Report for the Month of May 1981."

3.2 CRITICAL DESIGN REVIEW II

The second Critical Design Review (CDR-II) of TRIP was conducted during this extension period on May 5, 1981. A summary of the proceedings from CDR-II was published as DRC Report No. E-5896U.

The main objective of CDR-II was to determine if TRIP should be continued. CDR Committee discussions resulted in a number of conclusions which are summarized below.

Through the operation of the Experimental Data Bank (EDB), TRIP has proven that a national Rapid Rail Vehicle Data Bank is worthwhile and viable serving as a technical tool for the transit industry. More effort was still needed in certain minor areas in order to further enhance the usefulness of the data. These areas included:

- Inclusion of vendor/supplier and reference information in the data bank
- Development of conversion ("K") factors for use in uniformly interpreting the information presented in TRIP output reports
- Simplification of the Generic Part Number to emphasize equipment function and facilitate expansion.

The output reports which were being produced by the TRIP EDB accurately represented the authority data reported

by the participating authorities. Revisions made to EDB operating procedures since CDR-I had satisfactorily resolved discrepancies noted in earlier reports as the output reporting capability was being developed.

Even though the TRIP EDB was limited in scope to monitoring only three vehicle systems, the participating authorities, as well as the members of the TRIP Liaison Board, had already derived useful and beneficial results from TRIP. EDB output reports have been used to analyze the impact of scheduled inspections on maintenance/repair requirements, and then to justify alterations to inspection schedules. TRIP's "generic" approach to identifying components and defining maintenance activities has been used as a basis for developing and/or modifying maintenance information systems at several authorities represented on the TRIP Liaison Board.

The TRIP EDB had satisfactorily demonstrated the procedures for expanding the quantity of equipment and vehicles monitored by the Data Bank. This capability exists through TRIP's generic approach to equipment and maintenance action identification.

Based on these conclusions the CDR Committee made the following recommendations concerning TRIP:

- TRIP should be continued
- TRIP should commence Phase II

- TRIP should more fully utilize the complete EDB capacity with:

  - additional subsystems
  - additional fleets
  - additional participants

- TRIP should complete and document reference data.

3.3 LIAISON BOARD MEETING NO. 11

The 11th meeting of the APTA TRIP Liaison Board was held in conjunction with the CDR-II on May 6 & 7, 1981. Liaison Board members stated their assessments of TRIP resulting in a unanimous expression of support for the program and concurrence with the conclusions and recommendations of the CDR Committee.

3.4 CONTRACT COMPLETION

The RRV EDB level of effort tapered off during the next seven weeks in preparation for contract completion. Data for the month of May was received, input and processed during June. Data entry was terminated on June 30, 1981, and attention was focused on data validation and publication of "TRIP EDB Output Report for the Month of May 1981." Publication of this report completed the operational requirements of the RRV EDB under Contract Number DOT-TSC-1559.

3.5 SPECIAL REPORT NUMBER 6

A request for a Special Report from the TRIP EDB was received on July 7, 1981, from Booz. Allen & Hamilton, Inc., to support a study of transit vehicle door systems being performed under contract to UMTA. "TRIP EDB Special Report Number 6," DRC Report Number E-5968U dated July 30, 1981, was subsequently prepared with the approval of the Transportation Systems Center (TSC), and of the TRIP Liaison Board representatives from the authorities. Production of Special Report Number 6 was funded by Booz.Allen & Hamilton, Inc., and marked the first time that a Special Report was requested from TRIP by a "non-participant." (The first five Special Reports were requested by the TRIP Liaison Board.)

Two reports were produced for Special Report Number 6 from the unscheduled maintenance (repair) records contained in the TRIP EDB pertaining to the door and door control system of rail rapid cars at BART, CTA, NYCTA, and WMATA. Data for the month of February 1981 was selected for investigation by Booz. Allen & Hamilton, Inc. The first report displayed a listing of seven data elements from the unscheduled maintenance records: Authority; Generic Part Number; Generic Symptom Code; Generic Defect Code; Generic Repair Code; Generic Test Code; and Property Part Number* (PPN). The listing was sorted (in order) by Authority, Property Part Number*, and Generic Repair Code.

* The term "Property" is used when referencing technical aspects of TRIP.

The second report contained a display in matrix format of PPN's versus record counts by Generic Repair Code (GRC) category. Each cell in the matrix contained the physical count of records for each PPN contained in the data set as a function of GRC category. Line and column totals were provided. The matrix for each authority was displayed on a separate page(s).

SECTION 4 - ACTION AREA I REPORT SUMMARY

The Action Area I report describes the activities and efforts performed, and results achieved, under each task of Action Area I (AAI) under the second Contract, DTRS-57-81-C-00084.

4.1 CONTINUATION CONTRACT SCOPE

Contract Number DTRS-57-81-C-00084 began on August 3, 1981 covering a time period of 21 months through May 4, 1983. Work under this contract was divided into four (4) main action areas which were as follows:

Action Area 1. The operation and updating of the TRIP Experimental Data Bank (EDB) for Rapid Rail Vehicles (RRV) and the modification and improvement of the RRV-EDB operating procedures.

Action Area 2. Auxiliary duties to assure the continued success, viability and planned growth of the TRIP program, including:

- test and validation of the data outputs

- participating by DRC in the Critical Design Reviews

- performing other duties required to maintain TRIP viability and completeness.

Action Area 3. Documentation of the EDB relating to the transfer of the entire existing EDB from its current facility at DRC, to any other facility capable of operating a reliability data bank of this type.

Action Area 4. Support for the BUS/RRV EDB Merge, scheduled for the last six months of this contract, while continuing to operate the RRV-EDB.

4.2 ACTION AREA I TASK SUMMARY

The work performed under Action Area I is covered by the final report on Action Area 1 (DRC Report No. R-403U). The work performed under AAI spans 15 months, from contract commencement on August 3, 1981 through November 5, 1982. The goal of AAI was to improve and expand the RRV-EDB to bring it out of the developmental stage, during which it was termed "experimental", to a full-scale operating data bank. In pursuit of this goal, work performed under AAI was

divided into three (3) main tasks, being conducted simultaneously. They were:

- Task A - Operate the EDB at the activity level in force at the end of the preceeding contract

- Task B - Modify and Improve the Operating Procedures of the TRIP RRV-EDB as a result of experienced gained in operating the EDB under Task A and as a result of "external" forces due to changes in data submission

- Task C - Update the EDB.

The main areas of data bank updating and expansion are:

- additional authorities
- additional vehicle series
- additional vehicle systems
- Generic Part Number (GPN) simplification
- vehicle series designation improvement.

4.2.1 Task A Summary

4.2.1.1 Data Base Operation

Under this contract, DRC continued the operation of the TRIP EDB for Rapid Rail Vehicles (RRV) as established in the preceeding contract. The baseline EDB operation consists of monitoring three (3) vehicle systems on 1340 vehicles from

five (5) participating transit authorities. The five authorities and number of vehicles monitored at each were:

- Bay Area Rapid Transit District - BART - 437 cars
- Chicago Transit Authority - CTA - 194 cars
- New York City Transit Authority - NYCTA - 288 cars
- Port Authority Transit Corp. - PATCO - 121 cars
- Washington Metropolitan Area Transit Authority - WMATA - 300 cars

During the 15 month span of AAI three (3) railcar systems were being monitored:

- Doors and Door Controls
- Propulsion
- Friction Brakes

The continued operation of the EDB resulted in the growth of the data base from 134,771 records at the beginning of the contract to 210,445 records as of October 30, 1982. This represents an average monthly increase of 5,045 records per month over the 15 month period.

During this period corrections to the April and May 1981 Monthly Output Reports were published along with the June 1981, February 1982 and March 1982 reports. See DRC Report No. R-403U entitled "Action Cover I Report-Final Report" for a description of Monthly Output Report production during this period.

4.2.1.2 Special Report No. 7

This Special Report of the TRIP RRV-EDB was produced for N.D. Lea & Associates, Inc. to support its investigation and comparison of DC versus AC drive propulsion systems for the New York City Transit Authority (NYCTA). The primary purpose of this Special Report was to present detailed maintenance information of the OEM propulsion system of NYCTA's R-44 cars. Special Report No. 7 provides the data necessary to establish a reliability baseline for NYCTA's R-44 cam- controlled propulsion system.

In addition to presenting the detailed statistics, Special Report No. 7 contains a preliminary analysis, performed on the data for calendar year 1981. This preliminary analysis determined the distribution of maintenance actions among the various subsystems, major assemblies, assemblies, components, and repair codes.

4.2.1.3 Liaison Activities

In addition to operating the EDB and providing documentation in the form of updating the Operating Procedures Manual the the Program Maintenance Manual, Task A

of AAI includes the participation of DRC in TRIP liaison activities. During the course of AAI, DRC DB operating personnel worked with participating authority personnel in the areas of data submission and data anomaly correction. The primary liaison activities, however, were DRC's participation in the periodic meetings of the APTA TRIP Liaison Board (ATLB) which provided continuous guidance for the development of the TRIP RRV EDB. During the period covered by AAI, two ATLB meetings (nos. 12 & 13) were conducted. DRC participated in these meetings by familiarizing the ATLB members with TRIP operating and development activities.

4.2.2 Task B Summary

4.2.2.1 Input/Update Software Modifications

Modifications, improvements, and associated software changes, which provide a more streamlined data processing and analysis operation, were developed and implemented. The changes have made the internal processing of data more efficient, improved the DB analysis capabilities and increased the degree to which the system is "user friendly". The efficiency of the DB is, therefore, increased in both machine and human terms. The main areas of improvement were:

- Simplifying the Generic Part Number (GPN). The GPN, to which all specific Property Part Numbers (PPN) are cross-referenced, has been modified to provide a reliability assessment capability based

solely on function without reference to configuration. The input/update software has been modified to reflect the change, and new GPNs have been assigned to the PPNs.

- Improving the hard copy input screens. These screens have been reworked, and associated software modified, to provide a more logical grouping of data elements and to eliminate the unused fields and capabilities, thereby increasing the ease and efficiency of hard copy data input.

- Modifying Magnetic Tape Data Entry. In order to decrease the amount of duplicate records the data extract programs have been modified to hold one record, check subsequent records against it and not write another record until the fields that TRIP monitors change. This modification has greatly decreased the manual task of scrubbing duplicate records from the data base.

- Improving the Efficiency of Error Correction. In addition to the changes described in previous sections which increased the ease of both data entry for hard copy data and eliminated duplicate records on magnetic tapes, software modifications have been identified and implemented which decreased the degree of labor intensity involved in the error correction function.

- Improving Generic Parts List (GPL) Maintenance. The function of GPL maintenance/updating was made easier via a simple software modification. This function had been difficult and confusing because the entire record to be updated was not displayed either before or after changes were made. The modification displays the entire record, including the description field, (which may require changes even though it is not used by other software modules) after the Property Part Number is supplied. The user now knows the entire content of the record before and after changes are made.

- Adding WMATA TRIMAS/TRIP Interface. The Washington Metropolitan Area Transit Authority (WMATA) Transit Reliability Information Monitoring and Analysis System (TRIMAS) had been interfaced with TRIP, thereby eliminating the labor intensive effort of hard-copy data entry for WMATA. With the termination of TRIMAS by WMATA in anticipation of the implementation of its new Maintenance and Reliability System (which is not yet operational), TRIP has had to return to hard copy data entry for WMATA.

4.2.2.2 Output Software Modifications

Output report software had been developed and implemented which not only produced the Monthly Output Reports in the then desired new formats (reference: DRC Report No. E-7083U - "Sample TRIP Output Report Formats Revision I", February 5, 1982), but also was designed with

appropriate automatic expansion capabilities so that when additional authorities, vehicle series and/or vehicle systems are added to the Data Bank, they are automatically displayed in the output reports without the need to recompile programs.

4.2.2.3 Software Modifications for Data Base Expansion

As stated previously, the capabilities of the new report software allows the easy addition of new properties, vehicle series and/or vehicle systems. Specifically, the modifications in this area are:

- Improving how authority-specific information is processed. Authority-specific information has been removed from programs and is now held on files. This provides the flexibility to add new authorities and/or fleets to the Data Bank and change authority specific data without recompiling programs.

- Increasing the ease of vehicle system expansion. Vehicle System selection criteria have also been made external to the programs so that the inclusion of additional vehicle systems is independent of the computer software.

4.2.3 Task C Summary

Updating the Data Bank encompassed two main areas. One area involved improvements which increased the analysis capabilities of the system. Two distinct efforts were performed in this area of updating. They are:

- Generic Part Number Simplification - see section 4.2.2.1

- Vehicle Series Designator Modification. The vehicle fleet codes were modified to include same built-in "intelligence" to allow extract and analysis by fleet. Comparison of car types across as well as within authorities is now facilitated.

The other main area encompassed in updating the Data Bank was expanding the coverage to include an additional authority, vehicle series, and vehicle systems.

- Authority Expansion. The Metropolitan Atlanta Rapid Transit Authority (MARTA) was included as the sixth participating authority. The first month of data submitted by MARTA was for April 1982, and included data on all five vehicle systems.

- Vehicle Series Expansion. CTA's 2600 series vehicles was added to the Data Bank. The DB began accepting the data for these vehicles as they were put into service beginning in November 1981.

- Vehicle Systems Expansions. Two additional vehicle systems were included for monitoring by the DB. They are: ATO/ATC-Cab Signal and Auxiliary Electrical.

SECTION 5 - ACTION AREA II REPORT SUMMARY

As stated in the preceding section, Action Area II (AAII) of the Continuation Contract was concerned with auxiliary duties to assure the continued success, viability and planned growth of the TRIP program. The three tasks of AAII are:

Task A - Test and Validate the Data
Task B - Participate in Critical Design Review
Task C - Perform Other Duties (as directed)

5.1 TASK A SUMMARY

The twelfth ATLB meeting, held at the Washington Area Metropolitan Transit Authority (WMATA) in Washington, D.C. on September 2 and 3, 1981, resulted in a recommendation to place less emphasis on data validation and more emphasis on expanding the Rapid Rail Vehicle - Experimental Data Bank to include additional functional vehicle systems and at least one additional transit authority. Task A to test and validate the data, therefore, did not include a stringent engineering investigation of methods to test and validate the data and assess the appropriateness of the data for a particular application.

Work performed under this task of AAII primarily consisted of continuing, modifying, and improving the operational procedures and software associated with the data editing, error correction and validating functions.

5.2 TASK B SUMMARY

DRC participated in the third Critical Design Review (CDR-III) which was conducted in conjunction with the 14th meeting of the APTA TRIP Liaison Board on September 29 and 30, 1982 at APTA Headquarters in Washington, D.C. The purpose of CDR-III was to assess the current program and discuss UMTA's proposals for the redirection of TRIP based on UMTA's emphasis on the achievement of near-term benefits through improved maintenance and improved management. DRC's main contribution to the discussions of CDR-III consisted of defining the ramifications of the redirection options under discussion, providing assistance in developing alternative options and providing rough cost estimates of all options.

5.3 TASK C SUMMARY

Work performed under Task C of Action Area II (Perform Other Duties) resulted primarily from the discussions of CDR-III. DRC provided:

- Descriptions of the TRIP redirection options
- "Bare-bones" TRIP operation alternatives
- Preliminary budgetary cost estimates for the TRIP redirection options
- Descriptions of representative TRIP analysis topics and analysis report types.

SECTION 6 - TRIP ACTIVITIES SINCE PUBLICATION OF THE ACTION AREA I AND II REPORTS

The TRIP Action Area I and II Reports were published in December 1982 and February 1983 respectively. The purpose of this section is to summarize the activities since publication of these reports. This contract effort was for the August 31, 1981 to December 31, 1983 period.

6.1 ACTION AREA I ACTIVITIES

6.1.1 Task A - Activities

DRC has continued the operation of the TRIP Data Bank and participated in APTA TRIP Liaison Board (ATLB) Meeting Numbers 14 and 15. ATLB No. 14 was held concurrently with CDR-III on September 29 and 30, 1982 at APTA Headquarters in Washington, D.C. (See CDR-III Summary in Section 5 herein) ATLB No. 15 (the last meeting of the ATLB under this contract) was held on November 16 and 17, 1982 at APTA Headquarters. Discussions of the redirection options selected by UMTA resulted in the revision of TRIP Goals/Objectives and the means to achieve them (See Section I herein) and the re-prioritization of TRIP options by the ATLB.

The ATLB re-ordering of options for TRIP redirection is presented here in priority order.

- Priority 1, Option 14; Continue Current Trip Data Bank Coverage at: 6 Authorities; 5 vehicle Systems; 1500 Vehicles.

- Priority 2, Option 8B; Provision of Data to Suppliers/Car Builders in Support of Their Analyses to Demonstrate Cost/ Benefit.

- Priority 3, Option 8A: Productivity Analysis Using Existing Data.

- Priority 4, Option 13: Provide Reference Data to Support Inter-Authority Data Comparisons.

- Priority 5, Option 12: Accept and Report Transit System Performance Data.

- Priority 6, Option 16: Expand RRV-TRIP to Additional Authorities; Vehicle Types/Fleets; Vehicle Systems.

- Priority 7, Option 1B: Accept and Report Maintenance Labor Data.

- Priority 8, Option 15: Provide Interactive Output Access to the TRIP Data Bank.

- Priority 9, Option 17: Expand TRIP to Monitor Buses.

The above options were grouped as a function of various funding levels. They were:

Availability Funding	Priority Number(s) of Options
100K	1 ("Bare Bones" Operation)
200K	1 (Baseline Operation-defined above), 2 & 3
300K	1 (Baseline Operation), 2, 3, 4 & 5
400K	1 (Baseline Operation), 2, 3, 4 & 5 and 6 (some portion)

The UMTA selected options were as follows:

- Perform special analyses on TRIP as described in Option 8A, 8B and 8C (Priority 1)

- Provide technical assistance to implement or improve site-specific Maintenance Management Information Systems (Priority 6)

- Accept and report maintenance labor data (Priority 7)

- Continue the operation of TRIP at a reduced level-of-effort (Priority 2 - Modified)

- Some combination or variation on the above options.

An Action Item was formulated for DRC to review the impact on data bank operations of producing quarterly reports instead of monthly output reports. This resulted in DRC developing parallel capabilities to produce Quarterly Output Reports. Operation of the data base was continued (data input, processing and error correction) in anticipation of program continuance. The data base contains data through April 1983 for WMATA and is complete through September 1983 for all the other Authorities. Some additional data for October and November was entered for some Authorities before data entry ceased. Quarterly reports for the third and fourth quarter 1982 and the first and second quarter 1983 were subsequently published. The output report for the second quarter 1983 (last output report produced under this contract) does not contain WMATA data (WMATA was not able to forward the necessary data to the DB.

Other data base operation activities included the publication (December 3, 1982) of revised editions of the Operations Procedures Manual and the Program Maintenance Manual (DRC Report Numbers R-407U and R-410U respectively).

6.1.2 Task B - Activities

The only modification/improvement to the operating procedures performed since the publication of the Action Area I and II Reports was the development of parallel capabilities to produce Quarterly Output Reports in addition to the existing Monthly Output Reports.

6.1.3 Task C - Activities

The only area of data base updating accomplished since publication of the AAI and II Reports was completion of the effort to include the additional vehicle systems of ATO/ATC-Cab Signal and Auxiliary Electrical. MARTA was brought on-board monitoring these two additional vehicle systems. They were reported for MARTA in the Output Report for the Third Quarter 1982. They were reported for BART and just the Auxiliary Electrical for CTA in the Output Report for the Fourth Quarter 1982. The two additional systems appear for all participating authorities, but just the Auxiliary Electrical for CTA, in the Output Report for the first and second quarters 1983 (CTA cannot submit ATO/ATC data).

6.2 ACTION AREA II ACTIVITIES

Testing and validating the data consisted of continuing the data editing, error correction and validating functions previously developed and implemented. There were no further Critical Design Reviews of the program.

The Contract Modification added the following to TASK C of AAII (Perform Other Duties)

- Conduct a productivity analysis study. This analysis is restricted to the propulsion systems of PATCO and WMATA rapid rail vehicles. The propulsion system is the transit vehicle failure high-driver system throughout the industry and PATCO and WMATA are the only two participating authorities for which there is some maintainability data (labor hours by maintenance action) on the data base.

- Provide TRIP data to supplier/car builder in support of their analyses to demonstrate cost/ benefit of the program.

The productivity analysis (Special Report Number 8), DRC Report Number R-448U was published on February 17, 1984. Due to the uncertainty of the continuance of the TRIP program the funds allocated for the supplier/carbuilder data dump was put toward maintaining the Data Bank as part of a contingency plan for future TRIP activities.

6.3 ACTION AREA III ACTIVITY

Action Area III entails the production and distribution of the Rapid Rail Vehicle TRIP Functional Requirements Manual. This document describes the requirements which are met by the RRU-TRIP. The purpose of this manual is to provide a basis for mutual understanding between DRC, the system designer/operator, the transit industry and government of the definition of the software including requirements and operating environment. The final version of this document, DRC Report Number R-42422U was published on October 14, 1983.

SECTION 7 - SUMMARY AND CONCLUSIONS

The ongoing development and refinement of the TRIP Data Bank continued with the awarding of Contract Number DTRS-57-81-C-00084 on August 3, 1981. Table 7-1 is a listing of all major contract events starting with the initial contract award (Contract Number DOT-TSC-1559) in September 1978 and ending with the final versions of the Productivity Analysis and this Final Technical Report under Contract Number DTRS-57-81-C-00084. A listing of all the technical reports produced under both contract numbers is given in Table 7-2. Table 7-3 lists those reports which are available from the National Technical Information Service (NTIS).

7.1 RESULTS UNDER CONTRACT NUMBER DTRS-57-81-C-00084

The following is a general summary of the results and accomplishments under Contract Number DTRS-57-81-C-00084:

- Steady-state status of the "normal" logistics of data submission

- Improved operating procedures of the Data Bank. The modifications and associated software changes have made the internal processing of the data more efficient and have increased the ease of Data Bank expansion in the areas of adding new authorities,

vehicle fleets and vehicle systems. Specific areas of improvement include:

  - Input data error correction
  - Data processing
  - Data retrieval
  - Output report production
  - Externalizing authority-specific information and system selection criteria from the software programs.

- Inclusion of the Metropolitan Atlanta Rapid Transit Authority

- Inclusion of CATA's 2600 series cars

- Vehicle system monitoring expansion to include ATO/ATC-Cab Signal and Auxiliary Electrical Systems

- Improved analysis capabilities and ease of expansion as a result of:

  - Generic Part Number Simplification
  - Vehicle Series designation change

The above results and accomplishments have resulted in the attainment of the goal of improving and expanding the RRV-EDB to bring it out of the developmental stage, during which it has been termed "experimental". This term therefore has been dropped. TRIP is now considered to be a full-scale operating data base - the Rapid Rail Vehicle

Transit Reliability Information Program Data Bank (RRV-TRIP Data Bank).

7.2 CONCLUSIONS AND RECOMMENDATIONS

The TRIP concept of a national Rapid Rail Vehicle Reliability Data Bank, which collects, stores, and processes data generated by operating transit authorities in the course of revenue service operation and equipment maintenance, thereby assisting the transit industry in satisfying its need for transit reliability information, has been proven.

With the concept having been proven, TRIP should be utilized for continuing reliability information analyses and dissemination. Alternatives to the continuation of present operation include:

- No further data entry - perform analyses using existing data, such as Special Report Number 8 - Propulsion System Reliability/ Productivity Analysis (PATCO & WMATA).

- Use of TRIP in developing, refining or optimizing maintenance programs through the identification of system, subsystem, assembly, etc. failure rates.

TABLE 7-1

MAJOR CONTRACT EVENTS

DATE	EVENT
09-18-78	Contract Award
11-08-78	Kick-off Meeting
11-09-78	1st APTA TRIP Liaison Board Meeting, UMTA HQ
11-14-78	Visit to GIDEP, Corona, CA
11-15-78	Visit to BART, Oakland, CA
11-29-78	Visit to GCRTA, Cleveland,OH
11-30-78	Visit to CTA, Chicago, IL
12-06-78	Visit to NYCTA, New York, NY
12-08-78	Visit to PATCO, Lindenwold, NJ
12-12-78	Visit to WMATA, Washington, D.C.
12-18-78	Task 1 Draft Report
01-09-79	APTA RAMD Subcommittee Meeting
01-10-79	2nd APTA TRIP Liaison Board Meeting, APTA HQ
02-06-79	Task 3 Draft Report - Transit Vehicle Equipment Lists
02-06-79	Task 3 Draft Report - Operating Procedures
02-21-79	Task 2 Draft Report - Data Bank Scope and Definition
03-06-79	3rd APTA TRIP Liaison Board Meeting, APTA HQ First set of sample property data solicited
03-06-79	Railcar Standardization Interface Meeting
03-29-79	Task 4 Draft Report
04-13-79	Task 4 Interim Guidelines Report
04-24-79	4th APTA TRIP Liaison Board Meeting, APTA HQ
05-09-79	PATCO TRIP Familiarization Meeting
05-10-79	WMATA TRIP Familiarization Meeting
05-15-79	CTA TRIP Familiarization Meeting
05-16-79	GCRTA TRIP Familiarization Meeting
05-18-79	BART Generic Parts List Completed
05-19-79	WMATA Generic Parts List Completed
05-22-79	TRIP Generic Maintenance Actions Codes Book
06-08-79	Draft EDB Acceptance Test Plan
06-08-79	Draft EDB Acceptance Test Procedures
07-02-79	NYCTA TRIP Familiarization Meeting
07-13-79	EDB Acceptance Test Plan (Final)
07-13-79	EDB Acceptance Test Procedures (Final)
07-16-79	EDB Acceptance Test "Dry Run"
07-30-79	EDB Acceptance Test
08-15-79	Initiated EDB Operation • BART data as of 07/01/79 • WMATA data as of 07/01/79
08-29-79	Task 6 Draft Report - Railcar Standardization
09-14-79	1st Set of EDB Output Reports (July 1979)
09-17-79	July 1979 EDB Output Reports
09-18-79	5th APTA TRIP Liaison Board Meeting, APTA HQ
10-04-79	Revised July 1979 EDB Output Reports
10-19-79	Draft TRIP EDB Program Maintenance Manual

TABLE 7-1 (continued)

MAJOR CONTRACT EVENTS

DATE	EVENT
10-26-79	PATCO Generic Parts List Completed
10-31-79	RRV Data Collection Cost Estimate
11-06-79	Draft TRIP Software User's Manual
11-12-79	CTA Generic Parts List Completed
11-14-79	Initiated PATCO data entry - data as of 08/10/79
11-15-79	Initiated CTA data entry - data as of 08/01/79
11-21-79	August & September 1979 EDB Output Reports
11-27-79	6th APTA TRIP Liaison Board Meeting, APTA HQ
11-29-79	APTA RAMD Subcommittee Meeting
12-12-79	Bus-TRIP Contract Award
01-17-80	APTA Bus Technology Committee Meeting, UMTA HQ
01-29-80	NYCTA Generic Parts List Completed
02-18-80	TRIP Generic Maintenance Actions Codes Book (Revised)
02-19-80	Initiated NYCTA data entry - data as of 07/01/79
03-03-80	Extended TRIP Contract (EDB Operations) by 9 months
03-07-80	November 1979 EDB Output Reports
03-31-80	TRIP Critical Design Review - #1, APTA HQ
04-01-80	7th APTA TRIP Liaison Board Meeting, APTA HQ
04-14-80	TRIP Software Review, TSC
05-09-80	Contract Status Review, TSC
05-30-80	CDR-I Transcript
06-02-80	Output Report Software Functional Requirements
06-04-80	TRIP Project Review, UMTA
07-11-80	EDB Output Reports/March 1980
07-18-80	Special Reports Nos. 1, 2 & 3
07-22-80	8th APTA TRIP Liaison Board Meeting, TSC
08-05-80	Phase I Documentation Status Review, TSC
10-03-80	EDB Output Reports/June 1980
10-10-80	Special Report No. 4
10-15-80	9th APTA TRIP Liaison Board Meeting, MARTA
11-18-80	Special Report No. 5
12-02-80	TRIP Participants Guidelines (Final Report)
12-24-80	EDB Output Reports/July 1980
12-24-80	EDB Output Reports/August 1980
01-07-81	TRIP EDB Program Maintenance Manual (Final)
01-09-81	EDB Output Reports/September 1980
01-13-81	10th APTA TRIP Liaison Board Meeting, PATCO
01-26-81	EDB Output Reports/October 1980
03-06-81	EDB Output Reports/November 1980
04-01-81	TRIP EDB Operating Procedures Manual (Final)
04-13-81	TRIP RVDP for RRV (Final)
04-15-81	EDB Output Report/December 1980
04-29-81	TRIP Phase I Report (Final)
05-05-81	Engineering Change Order #1 Executed
05-05-81	TRIP Critical design Review #2, TSC

TABLE 7-1 (continued)

MAJOR CONTRACT EVENTS

DATE	EVENT
05-06-81	11th APTA TRIP Liaison Board Meeting, TSC
05-13-81	EDB Output Report/January 1981
06-12-81	EDB Output Report/February 1981
06-30-81	EDB Output Report/March 1981
07-17-81	EDB Output Report/April 1981
07-24-81	EDB Output Report/May 1981
07-30-81	Special Report No. 6
07-31-81	Termination of Contract Number DOT-TSC-1559
08-31-81	Commencement of Contract Number DTRS-57-81-C-00084
09-02-81	12th APTA TRIP Liaison Board Meeting, WMATA
10-31-81	Completion of TRIP/TRIMAS Interface
11-13-81	Approach to K-Factor Development
11-25-81	Output Report for the Month of "Sample"
11-28-81	Completion of Input Software Modification Effort
12-11-81	Output Report Formats Comparison
12-14-81	Generic Part Number Revision Vols. I, II, III & IV
12-28-81	EDB Output Report/June 1981
01-12-82	13th APTA TRIP Liaison Board Meeting, APTA HQ.
01-23-82	Completion of All Properties GPS'S (New GPN)
02-05-82	Sample TRIP Output Report Formats, Revision I
02-12-82	User's Guide PPN to TRIP GIN Conversion (BART & CTA)
02-20-82	Input Software Acceptance Test Completion
02-20-82	Data Base Conversion Completion
04-17-82	Completion of Output Software Modification Effort
05-11-82	Generic Part Number Revision Vols.IV & V
05-14-82	MARTA Generic Parts List Completed
05-27-82	EDB Output Report/February 1982
06-08-82	EDB Sample Output Report/February 1982
06-11-82	Input/Output Software Enhancements
06-21-82	Initiated MARTA Data Entry - Date as of -4-1-82
08-10-82	Special Report No. 7
08-19-82	EDB Output Report/March 1982
08-19-82	EDB Sample Output Report/March 1982
09-29-82	TRIP Critical design Review #3, APTA HQ
09-29-82	14th APTA TRIP Liaison Board Meeting, APTA HQ.
10-15-82	CDR-III Transcript Summary
11-16-82	15th APTA TRIP Liaison Board Meeting, APTA HQ.
12-03-82	Action Area I Report, Final Report
12-03-82	TRIP EDB Operating Procedures Manual Revised, Final
12-03-82	TRIP EDB Program Maintenance Manual Revised, Final
12-10-82	BART and CTA Generic Part List for ATO/ATC and Auxiliary Electrical
01-01-83	Term "Experimental" Dropped
01-07-83	Completion of Generic Part List for ATO/ATC and Auxiliary Electrical

TABLE 7-1 (continued)

MAJOR CONTRACT EVENTS

01-14-83	Hard Copy Input Program Changes for ATO/ATC and Auxiliary Electrical
01-21-83	Data Extract Program Changes for ATO/ATC Auxiliary Electrical (BART & NYCTA)
01-25-83	Selected Monthly Output Reports 6/81 - 5/82
02-04-83	Action Area II Report, Final Report
02-07-83	Data Extract Program Changes for ATO/ATC & Auxiliary Electrical (PATCO)
02-14-83	Parallel Capability for Quarterly Report Production
02-18-83	DB Output Report/Third Quarter 1982
04-18-83	Contract Modification Commencement
05-02-83	DB Output Report/Fourth Quarter 1982
07-15-83	DB Output Report/First Quarter 1983
09-03-83	Contract Extension Commencement
10-14-83	Functional Requirements Manual
12-14-83	Special Report No. 8 (Productivity Analysis-Draft)
01-09-84	Final Technical Report (Draft)
01-31-84	DB Output Report/Second Quarter 1983
02-17-84	Special Report No. 8 (Productivity Analysis - Final)
02-17-84	Final Technical Report (Final)
02-17-84	Contract Termination

TABLE 7-2

TECHNICAL REPORTS

NUMBER	REPORT TITLE / DESCRIPTION	DATE DUE	RPT DATE
E-4894U	Task 2 Report - Draft D.B. Scope and Definition	01-18-79	01-18-79
E-4895U	Task 3 Report - Draft Transit Vehicle Equipment List	01-18-79	01-18-79
E-4896U	Task 3 Draft Report Rel. Equip. List Operating Proc.	01-18-79	01-18-79
E-4965U	Task 4 Report - Draft	03-18-79	03-18-79
E-4998U	Task 4 Interim Report Operating and Use Guidelines	03-18-79	04-16-79
E-5042U	Trip EDB Generic Codes	NOT REQ.	05-22-79
E-5047U	Acceptance Test Plan Draft	FLEX.	05-25-79
E-5048U	Acceptance Test Procedure Draft	FLEX.	05-25-79
R-284U	Acceptance Test Plan - Final	FLEX.	07-09-79
R-285U	Acceptance Test Procedures EDB Final	FLEX.	07-09-79
E-5150U	Task 6 Report Draft Railcar Standardization Reliability Plan	08-20-79	08-20-79
E-5206U	EDB Output Report/July 1979	OPEN	10-04-79
E-5234U	Program Maintenance Man. Preliminary	07-01-79	10-19-79
E-5235U	EDB User's Manual Draft	06-01-79	10-19-79
	EDB Output Report/Aug. & Sept. 1979	OPEN	11-11-79
E-5361U	Generic Maintenance Action Codes	NOT REQ.	02-05-80
E-5385U	EDB Output Reports/Nov.1979	OPEN	03-07-80
E-5418U	CDR Presentation Materials	NOT REQ.	03-31-80
E-5505U	CDR Transcript	05-30-80	05-30-80
E-5553U	EDB Output Reports/Mar. 1980	OPEN	07-11-80
E-5562U	TRIP EDB Special Report No. 1	OPEN	07-18-80
E-5563U	TRIP EDB Special Report No. 2	OPEN	07-18-80
E-5564U	TRIP EDB Special Report No. 3	OPEN	07-18-80
E-5647U	EDB Output Reports/June 1980	OPEN	10-03-80
E-5664U	TRIP EDB Special Report No. 4	OPEN	10-10-80
E-5702U	TRIP EDB Special Report No. 5	OPEN	11-18-80
R-339U	Participants Guidelines (Task 4) Final	OPEN	12-02-80
E-5736U	TRIP EDB Output Reports/July 1980	OPEN	12-24-80
E-5744U	TRIP EDB Output Reports/August 1980	OPEN	12-24-80
R-337U	Program Maintenance Manual Final	09-30-80	01-07-81
E-5751U	TRIP EDB Output Reports/September 1980	OPEN	01-09-81
E-5773U	TRIP EDB Output Reports/October 1980	OPEN	01-26-81
E-5820U	TRIP EDB Output Reports/November 1980	OPEN	03-06-81
R-338U	Operating Procedures (User's)Manual Final	09-30-80	04-01-81
R-340U	Reliability Demonstration Plan for Rapid Rail Vehicles (Task 6) Final	09-30-80	04-13-81
E-5865U	TRIP EDB Output Reports/December 1980	OPEN	04-15-81
E-5869U	Phase 1 Report - Draft	09-30-80	04-20-81
R-341U	Phase 1 Report - Final	FLEX.	04-29-81
E-5881U	CDR-II Presentation Materials	NOT REQ.	05-05-81

TABLE 7-2 (continued)

TECHNICAL REPORTS

NUMBER	REPORT TITLE / DESCRIPTION	DATE DUE	RPT DATE
E-5970U	Final Technical Report Draft	07-31-81	07-31-81
	Final Technical Report Final	FLEX.	
E-5889U	TRIP EDB Output Reports/January 1981	OPEN	05-13-81
E-5912U	TRIP EDB Output Reports/February 1981	OPEN	06-12-81
E-5929U	TRIP EDB Output Reports/March 1981	OPEN	06-30-81
E-5945U	TRIP EDB Output Reports/April 1981	OPEN	07-17-81
E-5946U	TRIP EDB Output Reports/May 1981	OPEN	07-24-81
E-5968U	TRIP EDB Special Report No. 6	NOT REQ.	07-30-81
E-6084U	Approach to K-Factor Development	OPEN	11-13-81
E-6095U	Output Report for the Month of "Sample"	OPEN	11-25-81
E-7018U	TRIP Output Report, Old Versus Proposed New Formata Comparison	OPEN	12-11-81
E-7014U	Generic Part Number Revision Vol. I, II, III & VI	OPEN	12-14-81
E-7035U	EDB Output Report/June 1981	OPEN	12-28-81
E-7083U	Sample TRIP Output Report Formats Revision I	OPEN	02-05-82
E-7092U	User's Guide PPN to TRIP GIN Conversion (BART & CTA)	OPEN	02-12-82
E-7092U	Generic Part Number Revision VOL. IV & V	OPEN	05-11-82
E-8118U	TRIP EDB Program Maintenance	05-03-82	05-17-82
E-8105U	EDB Output Report/February 1982	OPEN	05/27/82
E-8135U	EDB Sample Output Report/February 1982	OPEN	06-08-82
E-8186U	TRIP EDB Special Report No. 7	OPEN	08-10-82
E-8215U	EDB Output Report/March 1982	OPEN	08-19-82
E-8216U	EDB Sample Output Report/March 1982	OPEN	08-19-82
E-8217U	TRIP EDB Operating Procedures, Revised Draft		09-03-82
E-8308U	Action Area I Report, Draft		09-17-82
E-8286U	DRC-III Presentation Materials	NOT REQ.	09-29-82
E-8362U	CDR-III Transcript Summary	10-15-82	10-15-82
R-403U	Action Area I, Final Report	12-03-82	12-03-82
R-407U	Operating Procedures Manual Revised, Final	12-03-82	12-03-82
R-410U	Program Maintenance Manual, Revised, Final	12-03-82	12-03-82
E-8442U	Action Area II Report, Draft	12-03-82	12-03-82
E-8483U	Selected Monthly Output Reports (6/81-5/82)	NOT REQ.	01-25-83
R-412U	Action Area II Report, Final	02-04-83	02-04-83
E-8526U	DB Output Report/Third Quarter 1982	OPEN	02-18-83
E-8660U	DB Output Report/Fourth Quarter 1982	OPEN	05-05083
E-8785U	DB Output Report/First Quarter 1983	OPEN	07-15-83
E-8844U	TRIP Functional Requirements Manual, Draft	08-20-83	08-19-83
R-422U	TRIP Function Requirements Manual, Final	10-14-83	10-14-83
E-9053U	Special Report No. 8 (Productivity Analysis)	12-14-83	12-14-83
E-8929U	Final Technical Report (Includes AAI & AAII Extension Reports), Draft	OPEN	01-06-84
E-9109U	DB Output Report/Second Quarter 1983	OPEN	01-31-84
R-427U	Final Technical Report, Final Report	OPEN	02-17-84
R-448U	Special Report No. 8 (Productivity Analysis) Final Report	OPEN	02-17-84

TABLE 7-3. TRIP NATIONAL TECHNICAL INFORMATION SERVICE REPORTS

NAME	AUTHOR	DATE	NTIS PB No.
TRIP - Participants Guidelines	Dynamics Research Corporation	March 1981	81-189276
TRIP - Phase I Report	Dynamics Research Corporation	June 1981	81-231425
TRIP - Reliability Verification Demonstration Plan for RRV	Dynamics Research	August 1981	82-118464
Evaluation of the TRIP	Carnegie-Mellon University Rail Systems Center	July 1982	83-117705
TRIP - Special Report No. 8, PATCO - WMATA Propulsion System Reliability/Productivity Analysis	Dynamics Research Corporation	February 1984	To be assigned
TRIP - Final Technical Report	Dynamics Research Corporation	February 1984	To be assigned

APPENDIX

REPORT OF THE QUANTIFICATION OF TRIP BENEFITS

REPORT OF THE QUANTIFICATION OF TRIP BENEFITS

PREPARED BY

TASK FORCE OF THE TRANSIT RELIABILITY
INFORMATION PROGRAM (TRIP) LIAISON BOARD

TASK FORCE MEMBERS

Robert W. Brindley (Mgr. RMSH, Budd Company)
James H. King, Jr. (Mgr., Reliability Engineering, BART)
Albert M. Lock, (Director of Systems Engineering, Houston-MTA)*
James Pankonen (Director, Systems Assurance, CTA)

APTA Program Manager: Theodore S. Gordon, P. E., Senior Engineer
Technical & Research Services Department

*Chairman - APTA Reliability, Availability, Maintainability & Dependability (RAMD) Subcommittee

TASK FORCE REPORT ON THE

QUANTIFICATION OF TRIP BENEFITS

The Transit Reliability Information Program (TRIP) sponsored by UMTA has been underway for several years. Six rail rapid transit systems (BART, CTA, MARTA, NYCTA, PATCO, and WMATA) contribute railcar subsystem reliability information to the program on a regular basis. The data bank containing this information has moved from the experimental to the operational stage.

An independent evaluation of the TRIP program was conducted previously (Report No. UMTA-MA-06-0126-82-1, Evaluation of the Transit Reliability Information Program by Dr. Richard A. Uher, Director-Rail Systems Center, Carnegie-Mellon University, July 1982). It concluded that a number of benefits are presently being realized and that the program has potential for future benefits should it be continued. However, this report was qualitative in nature, and it has been stated that the quantifiable benefits of the TRIP program remain elusive.

To address the issue of quantifiable benefits, a Task Force was formed at the request of UMTA's Office of Systems Engineering. It consisted of four members selected from the TRIP Liaison Board and the APTA TRIP program manager. In addition, recommendations are presented concerning future activities of the program.

The material contained herein is presented and discussed under the following headlines:

- Reliability Improvement Process
- TRIP Description for Users
- TRIP Potential Benefits
- Project Management

An attachment to this report identifies the manner by which each of the potential benefits of the TRIP program has been estimated.

RELIABILITY IMPROVEMENT PROCESS

In order to quantify TRIP program benefits it is necessary to first identify the framework or sequence of activity of the reliability improvement process. It can best be described in the steps detailed below:

1. Reporting (date bank compilation)
2. Analysis of information accumulated in data bank

3. Corrective Action (indicated by data bank)

4. Implementation of suggested corrective action(s)

5. Closed Loop Reporting (of corrective action(s) implemented)

6. Assessment of Effectiveness of Corrective Action

7. Determination of Cost Effectiveness of indicated corrective action(s)

At the present time, the TRIP program is involved in step one, REPORTING - to the transit industry. In this regard, it is important that UMTA, through its Public Information Office, make available TRIP output reports to potential, responsible transit industry user groups as rapidly as possible in order to foster the reliability improvement process identified earlier.

In the absence of any real cost data in the conduct of this work, the Task Force has made estimates in order to quantify the potential cost benefits cited herein. The reliability data used herein was extracted from the TRIP Data Bank Output Report for the First Quarter of 1983, DRC Report #E-8785U (July 15, 1983).

TRIP DESCRIPTION FOR USERS

It should be remarked that the TRIP Data Bank will be of minimal value to the transit industry unless it is used to effect reliability improvement of transit vehicles. APTA will promote utilization of TRIP by disseminating descriptive information to rail transit system operators, manufacturers, consultants, APTA committees and conducting workshops at APTA meetings. To facilitate its use, TRIP material must be easily comprehended; and it must be desirable to augment TRIP reports with graphical and illustrative material.

TRIP POTENTIAL BENEFITS

The Task Force has identified four areas of potential benefits that can be realized by the transit industry through the continuance of the TRIP program. They are identified below. In addition, the estimated value of each potential benefit over five years, in terms of 1983 dollars, is presented. As stated previously, an attachment to this summary identifies the assumptions and presents the manner by which each of the potential benefits have been computed.

POTENTIAL TRIP BENEFIT AREA	ESTIMATED SAVINGS OVER FIVE YEARS
1. New Car Reliability, Maintainability, Safety & Human Factors (RMSH) Programs	
Decrease in procurement cost of new vehicles as a result of diminished RMSH program requirements	$21.6 million

POTENTIAL TRIP BENEFIT AREA	ESTIMATED SAVINGS OVER FIVE YEARS
through use of TRIP data in specifying railcar requirements for emerging transit systems	
2. Optimizing Size of Car Procurements	
Reduction in fleet size due to increased car availability as a result of improved car reliability	$12.5 million
3. Reduction of O/M Costs	$12.8 million
Reduced operational and maintenance costs of existing transit systems through reliability improvement	
4. TRIP as Basis for Maintenance Management Information System (MMIS) Design	
The TRIP data processing functions are now on-line and operational. They can be used as a basis for MMIS design work by any transit system. The Transit Car Equipment Hierarchal (TCEH) Breakdown is generic and thus applicable to many different configurations of equipment	$1.5 million
TOTAL	**$48.4 million**

As noted above, the estimated benefits for TRIP over five years amounts to approximately $50 million dollars. This can be compared to the operating cost of the TRIP program which for the purpose of this exercise, was estimated to be $3 million dollars over a five year period of performance. It should be noted that if only slightly more than 10% of the potential cost benefit is actually realized, it would still result in a 2 to 1 benefit/cost ratio and justify continuance of the program. It must be noted that the point at which the benefits begin is dependent on completion of the "Reporting Process" (Step #1). This requires completion of the data base for at least the currently participating transit system and an adequate period of dissemination of the data to the industry.

PROJECT MANAGEMENT

In order to increase effectiveness and provide for faster and more detailed response to UMTA inquiries concerning cost parameters and financial management controls, a modification of the TRIP project management structure is recommended. The Liaison Board should have increased influence in defining tasks to be performed by the UMTA/TSC contractor. The data provided by transit systems for entry into the Data Bank could be utilized in a manner which enables optimization of processing within the Data Bank; this may result in additional cost saving measures with respect to Data Bank Operation. Possible cost reductions could be achieved during Step #2 (Analysis of Information accumulated in data bank) when preparing an analysis in response to a "special request" if the analyst interrogates the data bank only at data level consistent with the information germaine to the "special request."

ATTACHMENT A

TRIP BENEFITS

The computation of TRIP potential benefits is contained in this attachment. Four areas have been identified. They are noted below and the computation of each potential benefit is presented in subsequent sections of this attachment.

A. New Car RMSH Programs

B. Optimal Sizing of Car Procurement

C. Reduction of O/M Costs

D. TRIP as a Basis for MMIS Design

A. POTENTIAL BENEFIT OF NEW CAR RELIABILITY, MAINTAINABILITY, SAFETY & HUMAN FACTORS (RMSH) PROGRAMS

Significant cost savings in new car acquisition can be realized if RMSH requirements that are normally a part of the bid specifications could be reduced using TRIP data.

If the Transit Systems accept TRIP operational data for proposed equipment, or existing subsystem performance, then complicated equipment analytical efforts could be eliminated, including the associated elements of the RMSH program plans. It is estimated that between 30% to 50% of the cost of an RMSH program could be eliminated from new car bid prices, in effect giving the procuring agencies (federal, state, city, private) an option to either have more vehicles for less money or to simply accept the monetary benefit for other uses. To quantify this benefit the following assumptions are employed:

1. Assume 300 vehicles to be purchased each year for five years. (1500 vehicles)

2. Assume each procurement will average 150 vehicles.

3. Assume the average cost of a vehicle to be 1.2 million dollars.

4. Assume the cost of a RMSH program to be between 3.5 to 7.0 million dollars per procurement. (5.4 million on the average which is 3% of the procurement cost)

Calculations

a. Procurements per year = $\frac{300}{150} = 2$

Total number of procurements (5 year) = 5 X 2 = 10

b. Average RMSH program cost = $\frac{5.4 \text{ X million}}{\text{procurement}}$ X 10 = 54 million

c. Potential reduction of 30%-50% RMSH program cost (40% on average) through use of TRIP Data

54 million X 0.4 = 21.6 million

B. POTENTIAL BENEFIT OF OPTIMAL SIZING OF CAR PROCUREMENTS

The thrust of this benefit is to reduce or optimize the fleetsize which in turn will result in cost avoidance. This can be done by increasing car availability as a consequence of improved car reliability. To quantify this benefit the following assumptions have been employed.

1. Assume 300 vehicles to be purchased each year.
2. Assume each individual procurement will average 150 vehicles.
3. Assume the average cost of a vehicle to be 1.2 million dollars in 1983 dollars.
4. Assume a reduction (reliability improvement) of 0.4* unscheduled maintenance actions per 10,000 car miles of operation.
5. Assume an annual Operating and Maintenance (O/M) cost per car of $20,000.

It can be shown that a reduction of 0.4 unscheduled maintenance action per 10,000 car miles per month will effectively reduce the fleet size by one car in a 150 car order. The calculation is presented below using BART data.

	BART Current	BART Assumed
Rate of Unscheduled Maint. Action per 10,000 miles operated	4.50	4.10
Average Car Miles/Month	5420	5420
No. of Unscheduled Maint. Actions/Mo./Car	2.44	2.17

*See Appendix #1

	BART Current	BART Assumed
No. of Scheduled Maint. Actions/Mo./Car	.50	.50
Total No. of Maint. Action Cycles/Mo./Car	2.94	2.72
Average Time of Maint. Cycles/Mo./Car (Hours)	245	270
Up Time/Maint. Cycle	221	246
Down Time	24	24
Availability	.90	.91
No. of Cars Available/150 Cars	135	136
Approx. Change in Unsched. Maint. Actions per 10,000 miles to have One Additional Car Available	= 0.34	

The potential benefit of acquiring one less car per procurement over a five year period considering a reduction in procurement costs as well as (O/M) costs is computed below:

$$\frac{(300 \times 5)}{150} \times 1.2 \times 10^6 + (2 \times 10^4 \times 5 \times 5) = \underline{12.5 \text{ million}}$$

C. POTENTIAL REDUCTION IN OPERATING AND MAINTENANCE (O/M) COSTS

Reliability improvement in terms of reducing the number of unscheduled maintenance actions will result in lowering the operational and maintenance (O/M) costs. To quantify this benefit the following assumptions have been employed:

1. Assume 5,000 miles average per car per month.
2. Assume $20 thousand per car is average O/M cost per year.
3. Assume reliability, improvement of 0.4 unscheduled maintenance actions per 10,000 miles operated.
4. Assume current rate of 4.0 maintenance actions per 10,000 miles (Bart actual was 4.5 last period).*
5. Assume 1,282 cars in TRIP data bank (actual figure).

*(Maintenance actions per 10,000 is stated in DRC Report #E-8785U, TRIP Data Bank Output Report for the First Quarter 1983, Volume I-Industry, July 15, 1983.)

Calculations

Annual car mileage = 5,000 X 12 = 60,000 miles

Annual unscheduled maintenance actions per car = $\frac{4}{10,000}$ X60,000 =

Cost per maintenance action = $\frac{\$20,000}{24}$ = \$833

Annual maintenance actions per car with reliability improvement =

$\frac{(4.0 - 0.4)}{10,000}$ X 60,000 = 21.6

Annual Improved (O/M) Cost = \$833 X 21.6 = \$18,000

Annual Cost Reduction per Car = \$20,000 - \$18,000 = \$2,000

Annual Savings in O/M Cost = 1,282 X \$2,000 = \$2,564,000

Five Year Potential Benefit = \$2,564,000 X 5 = \$12.8 million
by improving reliability of
1,282 cars presently in the
TRIP Data Bank.

D. POTENTIAL BENEFIT OF USING TRIP AS BASIS FOR MAINTENANCE MANAGEMENT INFORMATION SYSTEM (MMIS) DESIGN

The TRIP data processing program has been developed, debugged and is operational. Included in this work is a "transit car hierarchy" which is a breakdown by level of indenture of transit car subsystems elements. This TRIP material may be used as a basis for design of MMIS by an emerging transit system. To quantify this benefit, the following assumptions have been employed.

1. Assume one emerging or existing transit system per year will design or redesign a MMIS system for five years.

2. Assume four man-years of effort of management system design time required to duplicate TRIP material in MMIS system design at a cost of \$75K per man-year.

   \$75K X 4 = \$300K

3. Potential benefit of five MMIS systems for five years

   \$300K X 5 = \$1.5 million

For 150 Cars

△ .1 of A = 15 of # Cars

△ .01 of A = 1.5 of # Cars

MTBF	400	300	200	100
A	.9524 (0.015)	.9375 (0.029)	.9090 (0.076)	.8330
F/1000H	2.5	3.3	5.0	10.0
F/10,000 MI	0.93	1.2	1.85	3.7

MTBF	75	50
A (.444)	.7895 (.075)	.7143
~~F/1000H~~	13.3	20.0
F/10,000 MI	4.9 (2.5)	7.4

The impact is non-linear however.

In the range of current data the delta ratio of ME/10,000 MI to A is 2.5/.075

∴ A change of -0.3/10,000 CH in ME rate would be the equivalent of adding 1 car.

Nomenclature

A = Availability

F = Failure(s)

H = Hours

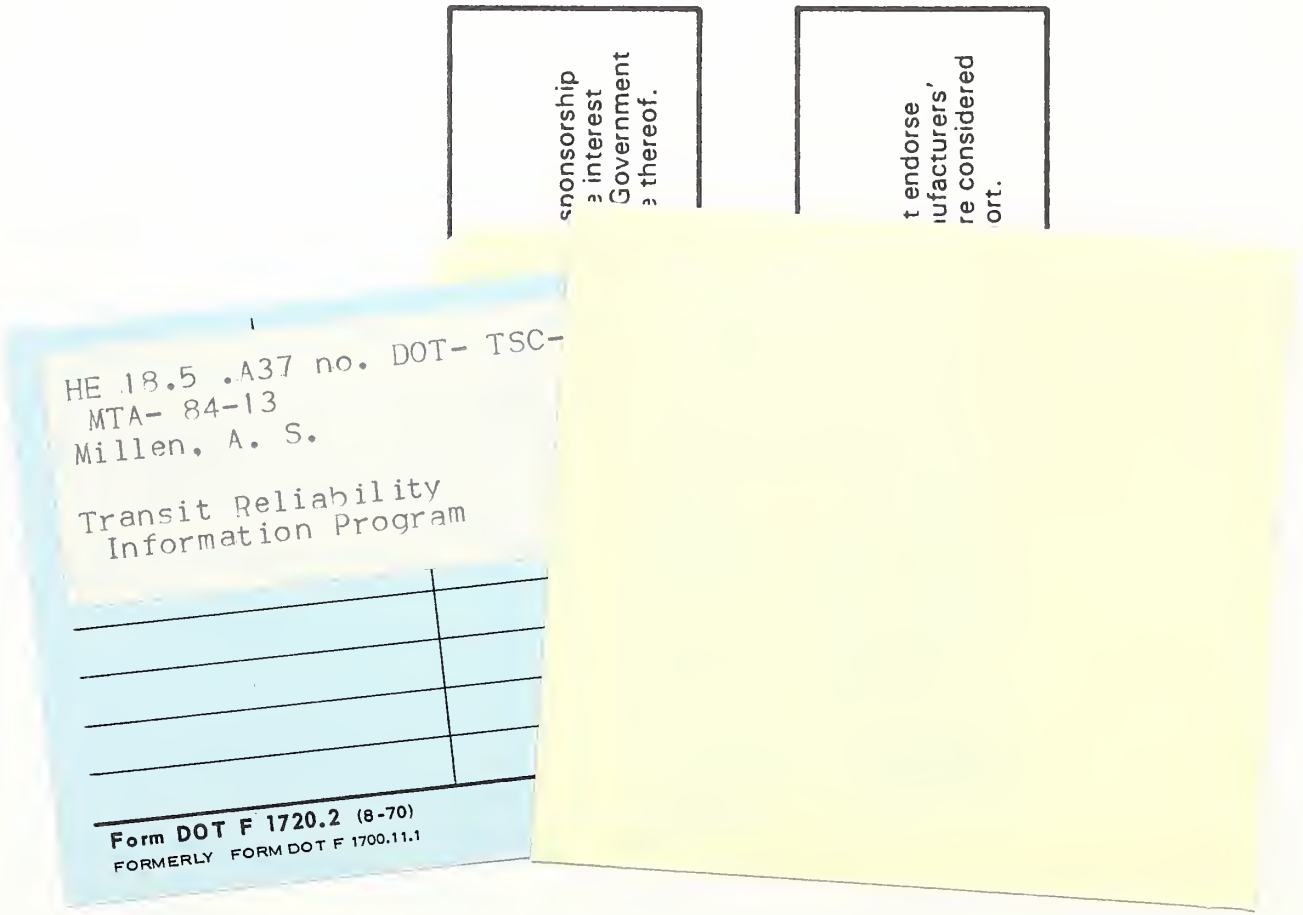
MI = Miles

CH = Car Hours

ME = Maintenance Actions

Calculations by:
James H. King, Jr. (BART)

85 copies


HE 18.5 .A37 no. DOT- TSC-
MTA- 84-13
Millen, A. S.

Transit Reliability
Information Program

Form DOT F 1720.2 (8-70)
FORMERLY FORM DOT F 1700.11.1

DOT LIBRARY
00352989

. Department
Transportation
search and
pecial Programs
dministration

ndall Square
mbridge, Massachusetts 02142

Official Business
Penalty for Private Use $300

Postage and Fees Paid
Research and Special
Programs Administration
DOT 513